Using computer vision to detect obstacles on surfaces

**Project proposal**

## Project description

The project aims to use computer vision to identify obstacles at surface level to help visually impaired people mobility in society. In order to achieve the aim of the project, Java programming language is going to be used, as well as Weka open source software. A program will be written and used for the purpose of separating images with obstacles from those without obstacles. By using Weka open source software, a suitable classifier is going to be chosen, and further training is applied in order to consider various surfaces with different types of obstacles (e.g. objects on the floor, including sides of the pavements, trees etc.). Hardware used for this project includes camera and vibration motors, all of these should be mounted on a belt worn by the user, in order for the camera to process the data, a wireless module should be used to send the images to a processing unit (a computer, raspberry pi for instance), which would notify the user when they have encounter an obstacle.

## Related work and existing projects

The literature review will focus on two articles, which are both about smart canes. However although they look similar in device the technologies that build up the canes differ as one smart cane uses the sonar ultrasonic transducer sensors and the other ultrasonic waves that enable the user to detect obstacles without touching them.

The first device uses ultrasound waves to observe an obstacle that is adjacent to the user and warn the user by vibration, however in the article it has not been mentioned what type of vibration has been used “*The device uses a certain vibration pattern to alert the user*”, nevertheless, it has been mentioned that the reason of using vibration and why it is better than using a sound technique is because the user might not be able to hear it at a noisy place “*The vibration* [*ensures that the user is warned*](http://www.techtree.com/content/features/6768/affordable-smartcane-uses-sonar-guide-visually-impaired.html) *of obstacles; a sound alert may not be audible on noisy streets.”*(Chandrakant 'CK' Isi, 2014)*.* However, The second deviceworks by using ultrasonic waves that allows the user to be aware of any obstacle at an earlier stage without the need for the cane to touch the obstacle itself *“*‘*smart’ cane that helps the blind navigate their way without having to touch or run into obstacles”*(Chetna Yerunkar, 2014).

From research both of these smart canes have helped individuals to move around and navigate for themselves without moving into obstacles. For example the first smart cane enables people to detect objects on roads and pathways but the article does not specifically state how high or low the smart cane can detect objects. However, the second smart cane is able to detect objects above knee level compared to the first device. It can also detect objects up to the distance of 3 meters outside and 1.8 meters indoors which the first device does not (the article does not specifically mention how far the cane can detect objects). The vibration and sound gets louder as the individual gets closer to the object/obstacle. Comparing the articles the first device (smart cane) does not expose any key features on how the sonar enhances the guidance of the smart cane, as it does not mention the qualities of the product as the second device explains such as the battery life and distance of detection.

Comparing both of these smart canes to the proposed device is that the end product will be a belt, which is more discreet than other devices. It will also feature more advanced technology such as computer vision, AI and neural network techniques (it has not been completely decided if neural network techniques is going to be used yet). One advantage of the belt is that blind individuals do not have to carry the stick rather then it being an option (they could still use the stick depending on their choice rather it being forced upon them, as the belt will do all the work). Having read many articles about blind young learners being bullied inside and outside of education reveals that young people are more less confident with using the stick as the belt will help encourage them to gain more self-confidence in education and society.

## Deliverables

The deliverables of the project would be a working system and the processing unit that would assist the user wearing the belt, which will detect any possible obstacles in the way or on the surface in front of them by vibration using vibration motors.

* A program that is manually classifies the samples that have been collected in order to distribute them as positive and negative (30th of November)
* A classifier that is trained for this purpose using Weka open-source software (30th of January)
* An integrated program that is able to merge all the hardware and software components together (15th of March)
* A communication module that transmits data from and to the processing unit to and from the wearable belt (15th of May)

## Aims and objectives

### Aims

* What are the ways to use computer vision techniques to help visually disabled people to avoid obstacles on the street?

### Objectives

* Finding a suitable feature that could be used as input to the classifier algorithms
* Finding a suitable classifier technique to distinguish images with and without obstacles.
* Achieving a smooth communication between all the software and hardware components of the project.

## Methods

### Experiments

Once enough information is gathered about the way other researchers have done the work (e.g. for example experiments that have been designed in order to give direction to the project), one of the main experiments would be implementing (or using the already implemented) classifiers to evaluate their suitability in the context of the current project. Weka open-source software will be one of the main resources for classifying the input data.

Another important element is the training of the classifiers, which are different from one another and different approaches might be taken for each one. Once the classifiers are tested, the most suitable one is chosen for the project and further adjusted and adapted to the aim of the project.

An important part of this project is also finding a suitable feature (or a combination of them) that could accurately describe the input image before inputting them to the classifying for the training (and then testing) purposes.

The project starts by capturing some videos from different places, which are then turned into individual frames, and each frame will be cropped into 3 sections. Each cropped image is then classified manually as to whether they have obstacles or not. Therefore, there will be two groups of data in separate folders one from each category. These images are then resized in order to extract the features from them (to be used later by the classifiers). These features can be simply the pixel values of the images, or more complex features such as Histogram of Oriented Gradients Descriptor (HOGDescriptor) from OpenCV library may also be used. These features are then converted into CSV files, which will then be used in Weka open-source software in order to classify the images into those with or without obstacles.

The Hardware programming part of the project is an essential part of the work, as there will be several components, which have to communicate with each other smoothly and transfer the values to the processing unit (where all the data are processed and the decisions are taken as to whether an image contains obstacles or not).

### Evaluation

Once the experiments are conducted, the project is evaluated in other environments and new users are asked to use the system to make sure that aim of the project is achieved.

## Gantt chart

Oct 2015

* Background research on the topic
* Reading about different classifiers
* Collecting samples (images) in order to train the classifier
* Coding the initial part of the project
  + Using Opencv libraries
  + Some image processing
* Images will be classified between positive and negative samples

Nov 2015

* Background research on the topic
* Initial testing of the different classifiers
* Testing different features and their suitability for the classifiers

Dec 2015

* Initial testing of the different classifiers
* Choosing a suitable classifier to focus the project on

Jan 2016

* Further experiments with the chosen classier
* Programming of the hardware components

Feb 2016

* Programming of the hardware components
* Working on the wireless component
* Testing and the training the classifier with new images
* Start writing the report

March 2016

* Testing the system in the real-world
* Working on the report

April 2016

* Evaluating the system with new users
* Adjusting the program based on the feedback collected
* Working on the report

May 2016

* Finalising and submitting the report

## Resources required

* Opencv libraries for computer vision part of the task
* Images collected that will be used to training the classifiers
* Weka open source software
* Camera and vibration motors.
* Raspberry Pi or Arduino for communicating with the hardware components

## Books and articles

* Chandrakant 'CK' Isi. (2014). *Affordable SmartCane Uses SONAR To Guide Visually Impaired.* Available: http://www.techtree.com/content/features/6768/affordable-smartcane-uses-sonar-guide-visually-impaired.html. Accessed on 25th Oct 2015.
* Chetna Yerunkar. (2014). *IIT-Delhi creates affordable 'smart' cane for the blind .* Available: http://www.mid-day.com/articles/iit-delhi-creates-affordable-smart-cane-for-the-blind/15506173. Accessed on 25th Oct 2015.
* Dalal, N., and B. Triggs. 'Histograms Of Oriented Gradients For Human Detection'. *2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition (CVPR'05)* (2005): n. pag. Web. 13 Sept. 2015.
* *Opencv 3.0 Computer Vision With Java*. Print.
* Russell, Stuart J, and Peter Norvig. *Artificial Intelligence*. Englewood Cliffs, N.J.: Prentice Hall, 1995. Print.
* Szeliski, R. 2011;2010;, *Computer Vision: Algorithms and Applications,* Springer London, London